Japanese Kokoku Patent No. Hei 3[1991]-63377

Translated from Japanese by the Ralph McElroy Company, Custom Division
P.O. Box 4828, Austin, TX 78765 USA

Code: 1314-20609

JAPANESE PATENT OFFICE

PATENT JOURNAL

KOKOKU PATENT NO. HEI 3[1991]-63377

Int. Cl.[5]:	A 61 B 17/36
Sequence Nos. for Office Use:	7916-4C
Application No.:	Sho 59[1984]-187782
Application Date:	September 7, 1984
Kokai No.:	Sho 61[1986]-64242
Kokai Date:	April 2, 1986
Publication Date:	September 30, 1991
No. of Inventions:	1 (Total of 4 pages)

LASER BEAM SIDE IRRADIATING FIBER

Inventors: Daisada Hashimoto
2-8-7 Nishikata,
Shinjuku-ku, Tokyo

Toshio Suzuki
Hitachi Cable Ltd.
2-1-2 Marunouchi,
Chiyoda-ku, Tokyo

Koichi Abe
Cable Research Laboratories, Hitachi Cable Ltd.
5-1 Hidaka-machi, Hitachi-shi

Masane Suzuki
Fuji Photo Optical Co., Ltd., 1-324 Uetake-cho, Omiya-shi

Motonori Kanatani
Fuji Photo Optical Co., Ltd., 1-324 Uetake-cho, Omiya-shi

Applicants:

Daisada Hashimoto
2-8-7 Nishikata, Shinjuku-ku, Tokyo

Hitachi Densen K.K.
2-1-2 Marunouchi, Chiyoda-ku

Fuji Photo Optical Co., Ltd., 1-324 Uetake-cho, Omiya-shi

Agent:

Kenzo Matsuura, patent attorney

References Cited:

Japanese Kokai Patent Application No. Sho 60[1985]-108804
Japanese Kokai Patent Application No. Sho 60[1985]-53161
Japanese Kokai Patent Application No. Sho 59[1984]-120148

[There are no amendments to this patent.]

Claims

1. A type of laser beam side irradiating fiber characterized by the following facts: in this laser beam side irradiating fiber, the laser beam transmitted in the fiber conductor made of a core and a cladding having different refractive indexes has its optic path reflected and bent by about 90° so that the laser beam is output to the side with respect to the length of the fiber;

an inclined surface is formed at the tip of the fiber base at an angle of about 45° with respect to the central line of the fiber; the end portion of the fiber base conductor including the aforementioned inclined surface is fitted with a transparent cylinder with one end closed so that the aforementioned inclined surface is sealed, and an air layer is set adjacent to the inclined surface, and the inclined surface becomes a total reflection surface.

2. The laser beam side irradiating fiber described in Claim 1 characterized by the fact that on the aforementioned transparent cylinder, an air injecting opening is connected to the gap formed by the fiber base conductor and the flexible tube installed on it.

Detailed explanation of the invention

Industrial application field

This invention concerns a type of laser beam side irradiating fiber. More specifically, this invention concerns a type of laser beam side irradiating fiber used for irradiating the laser beam from the side on the lesion portion in lumina of viscera via an endoscope.

Background of the invention

With rapid progress achieved in laser technology and optical fiber technology, the diagnosis and treatment of lesions, such as tumors, etc., in lumina of viscera by endoscopic irradiation via a laser beam have been actually used in clinical operation. Fibers used for irradiating the lesion portion with the laser beam transmitted endoscopically into the lumina of viscera include the direct irradiating type fiber in which the output end surface is at a right angle to the length of the laser beam side irradiating fiber. When the direct irradiating type fiber is used endoscopically, the endoscope's movement is limited within the narrow lumina of viscera, and movement may be not be possible at certain sites. In some cases, although the lesion portion is in the field of view, it is still impossible to irradiate via laser beam. In other cases, since the lesion or its vicinity is deformed, the lesion simply cannot be irradiated. These are disadvantages.

When the laser beam side irradiating fiber is used together with the direct irradiating type endoscope, the laser beam side irradiating fiber is led almost parallel to the optical axis of the object lens of the endoscope; hence, the lesion portion is irradiated in the tangential direction. Consequently, the near portion is irradiated with higher energy, while the remote portion is irradiated with insufficient energy. That is, nonuniform irradiating energy is unavoidable in this case. As the lesion may be deformed, there may be a portion which cannot be irradiated at all. Nonuniform irradiation energy is a serious problem in clinical practice.

A uniform distribution of the irradiating energy can be realized by normal irradiation of the laser beam onto the lesion portion. In this respect, there have been efforts to realize normal incidence irradiation of the lesion portion by means of a so-called oblique-view endoscope or side-view endoscope. However, for both the oblique-view and side-view endoscopes, the observed field of view is much narrower than that of the direct-view endoscope. Consequently, they are not ideal means in consideration of ease of surveying and observing the lesion portion, as well as ease of treatment as the laser beam side irradiating fiber is used. In the case when the side-view type endoscope is used, in order to lead out the irradiating fiber, its tip side has to be bent significantly. With the presently available material of the fiber base conductor, there is a high possibility of damage by folding. If the damaged parts are left in the human body, an extremely dangerous condition for the patient results.

In Japanese Patent Application No. Sho 58[1983]-161585, the present applicant disclosed a type of laser beam side irradiating fiber which makes use of the characteristics and advantages of the direct-view type endoscope in observation via normal incidence irradiation of the lesion in the lumina of viscera. For the laser beam side irradiating fiber proposed in Japanese Patent Application No. Sho 58[1983]-161585, the output end is formed as an inclined surface at about 45° with respect to the central axis of the fiber base conductor; the laser beam transmitted in the fiber has its optical path reflected and bent at about 90° and is output to the side from the side surface of the fiber. In order to increase the reflective efficiency of the inclined reflective surface, a reflective film is coated on the outer surface of the inclined surface. This type of laser beam side irradiating fiber well realizes the initial purpose, namely, irradiation of the inner wall of the luminal organ by the laser beam from the laser beam side irradiating fiber. However, it nevertheless has the following disadvantages for practical applications. For the reflective film coated on the inclined reflective surface at the output end of the fiber base conductor, sufficient reflectivity cannot be realized, and the energy loss is increased. As a result, the reflective film degrades and may even burn. This problem may develop easily as the output energy of the laser beam increases. In this case, the tip portion of the fiber base conductor itself may burn. Since the laser beam irradiating fiber is used in the lumina of viscera, blood or other body fluids may accumulate on the reflective coating layer on the tip portion of the fiber. Accumulation of the foreign

substances further reduces the output energy level at which the fiber tip burns.

On the other hand, for the medical laser beam irradiating fiber, the length should be in the range of 1.5 mm-several meters. It is rather difficult to form a reflective coating layer only on the minute area on the tip of the fiber base conductor with the aforementioned length. For example, the coating process becomes difficult using the vacuum evaporation operation. Also, since the entire fiber base conductor is heated to a high temperature, the primary coating layer may be degraded or damaged, and the fiber base conductor may be easily damaged due to folding.

Second, since the tip of the output side of the fiber base conductor is formed at an acute angle, it may be easily damaged. In particular, damage may easily take place as the laser beam irradiating fiber is led into the lumina of viscera via the endoscope. As damage takes place for the acute-angle portion of the tip of the output side of the fiber base conductor, partial peeling of the reflective coating layer formed on the reflective surface may take place, and burning of the peeled portion may occur.

Also, the acute-angle portion of the fiber base conductor may easily scratch the inner wall of the luminal organ. This is very dangerous.

Purpose of the invention

The purpose of this invention is to solve the aforementioned problems of the conventional methods by providing a type of laser

beam side irradiating fiber characterized by the fact that it has a highly reflective output end without the formation of a reflective coating layer on the laser beam reflective surface, and it is not damaged by burning.

Another purpose of the invention is to provide a type of laser beam side irradiating fiber characterized by the fact that the output end of the laser beam does not scratch the inner wall of the luminal organ.

Summary of the invention

According to this invention, the output end of the laser beam side irradiating fiber is formed as an inclined surface at about 45° with respect to the central axis of the fiber base conductor, and it is fitted with a transparent cylinder with one end closed and not in the form of an acute angle; an air layer is formed on the back of the inclined output surface of the fiber base conductor. Consequently, a high reflectivity can be realized without forming a reflective coating layer on the inclined surface, and it is thus possible to prevent damage by burning of the output end of the fiber and scratching of the inner wall of the luminal organ.

Application examples

In the following, this invention will be explained in more detail with reference to an application example illustrated by annexed figures.

Figure 1 is a cross-sectional view of an application example of the laser beam side irradiating fiber of this invention. Figure 2 is a cross-sectional view cut along line II-II in Figure 1. Fiber base conductor (11) is a conventional optical fiber base conductor made of glass or plastic, with a configuration made of a core and a cladding having different refractive indexes. In this application example, the fiber base conductor is a fused silica fiber with a core size of 400 μm and with an outer diameter of the cladding layer of 650 μm. Over the entire length of fiber base conductor (11), a primary coating layer (12) is formed. Fiber base conductor (11) with said primary coating layer (12) formed on it is further protected by a flexible protective coating tube (13) which can prevent cracks on fiber base conductor (11) or damage by folding of fiber base conductor (11). Said protective coating tube (13) is preferably made of a vinyl resin material, nylon, teflon, or another synthetic resin material. In order to bend the laser beam at a right angle to the length of the fiber in which the laser beam is transmitted, the end portion of fiber base conductor (11) is polished to an optically smooth surface (14) inclined at about 45° to the central axis of fiber base conductor (11). For fiber base conductor (11) with its tip formed at an inclined surface (14) at 45°, a portion containing the tip has primary coating layer (12) and protective coating tube (13) peeled off. After peeling of the primary coating layer and protective coating tube (13) from a portion of the fiber, the output face of fiber base conductor (11) is equipped with a transparent cylinder (15) having one end closed in a hemispherical shape and having a circular cross section, with air-tight bonding between them by means of epoxy

type adhesive (16). Within said transparent cylinder (15), an air layer (17) is formed between the inner surface of cylinder (15) and inclined surface (14) of fiber base conductor (11) as ensured by an appropriate setting of inclined surface (14) of fiber base conductor (11). A step portion (17) is formed over the entire periphery of the opening end side of transparent cylinder (15). On this step portion (18) [sic; 17], the tip portion of a feed [sic; reinforcing] tube (19) for protecting and feeding [sic; reinforcing] fiber base conductor (11) over the entire length, made of teflon or other flexible material is fixed by bonding or by heating to enlarge the inner diameter, followed by installation and then cooling and shrinking for fixing. Between the inner periphery of said reinforcing tube (19) and protective coating tube (13) of fiber base conductor (11), a gap (20) with a circular annular cross section is formed over the entire length. For this purpose, it has appropriate inner diameter and a shape almost identical to the shape of transparent cylinder (15).

For a portion of transparent cylinder (15), when the tip of fiber base conductor (11) and the tip of reinforcing tube (19) are fitted, a groove (20) connected to said gap (21) is formed.

For the laser beam side irradiating fiber with the aforementioned configuration, the laser beam transmitted through fiber base conductor (11) is totally reflected from the inclined surface at about 45° and in contact with an air layer (17). The optical path is bent at a right angle and exits from the side surface of transparent cylinder (15). At the same time, pressurized air is fed into gap (21) set to cover the entire outer circumference of fiber base conductor (11), it is then

ejected to the outside through groove (20) formed in transparent cylinder (15) connected to said gap (21). In this way, a portion of transparent cylinder (15), that is, the peripheral portion including the laser beam output portion, can be cooled, and overheating can be prevented.

In the aforementioned application example, for the laser beam side irradiating fiber, in order to reflect the laser beam transmitted in the fiber base conductor by about 90° so that the laser beam exits to the side with respect to the direction of the field of view of the endoscope, the reflective surface is formed as a total reflection surface on the tip portion of the fiber base conductor with an air layer formed adjacent to the reflective surface equipped with a transparent cylinder with one end closed. Consequently, there is no need to form a reflective layer as in the conventional method, and the various disadvantages caused by the reflective coating layer in the conventional laser beam irradiating fiber can be avoided.

On the other hand, in order to form a total reflection surface of the tip of the output side of the fiber base conductor, an air layer is formed adjacent to the reflective surface by fitting the tip portion of the fiber base conductor with a transparent cylinder with one end closed to a nearly hemispherical shape. It is thus highly resistant to damage, and there is no danger of scratching of the inner wall of the luminal organ by the fiber.

In the aforementioned application example, the transparent cylinder may be made of various types of materials, such as plastics, glass, ceramics, etc., as long as the material used can meet the requirements of transmissivity, refractive index, and

other desired optical characteristics. In particular, it is preferred that materials in which the accumulation of foreign substances is inhibited with high heat resistance be used. Or, a coating may be formed on the outer periphery so as to improve the application performance.

Effects of the invention

As explained in the above, for the laser beam side irradiating fiber of this invention, the end portion of the fiber base conductor is equipped with a transparent cylinder with one end closed; this transparent cylinder is used to seal off the inclined surface of the fiber base conductor. Consequently, the laser beam can be led into the lumina of viscera via endoscope, and can irradiate the lesion portion at normal incidence. In addition, as the aforementioned inclined surface is sealed off by the transparent cylinder, accumulation of foreign substances on the inclined surface can be reliably prevented. In addition, since the cylinder is transparent, the state of the overall inclined surface of the fiber base conductor can be observed from the outside. Consequently, the safety of the inclined surface of the fiber base conductor can be easily confirmed.

Brief explanation of the figures

Figure 1 is a cross-sectional view of an application example of the laser beam side irradiating fiber of this invention. Figure 2 is a cross-sectional view cut along II-II in Figure 1.

11, fiber base conductor
12, primary coating layer
13, protective coating tube
14, inclined surface
15, transparent cylinder
17, air layer
19, reinforcing tube
20, ejecting opening
21, gap

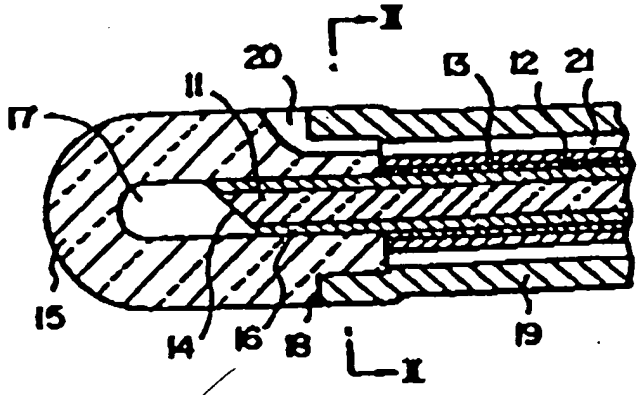

Figure 1.

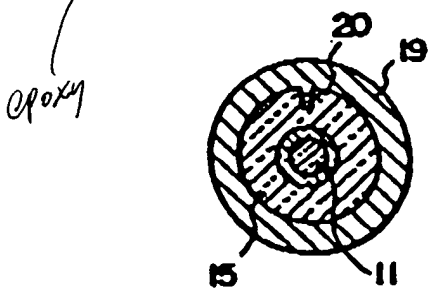

Figure 2.